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(54) Finger follower arm

(57) A finger follower arm (50) is provided for mounting on a support post (92) to transmit oscillatory motion from a cam to a poppet valve (91) to cause the valve (91) to move linearly between open and closed positions. The arm has a support post end (64) including a downwardly open domed socket (70) for engagement on the support post (92) and an upstanding peripheral wall (68). A tappet valve end (76) has a W-shaped cross-section and has a bridge piece (78) defining a downwardly open channel (84) having parallel side surfaces (86,88) and a downwardly facing bearing surface (90) between the side surfaces (86,88) for engagement with said poppet valve (91). A pair of upstanding spaced-apart side walls (72,74) extend between the support post end (64) and the tappet valve end (76) and blend into the peripheral wall (68) which extends continuously between the side walls (72,74) to rigidify the support post end (64). The bridge piece (78) and side walls (72,74) are separated by grooves (80,82) which combine with the bridge piece (78) and the side walls (72,74) to define the W-shaped cross-section. A method of manufacture is also described.

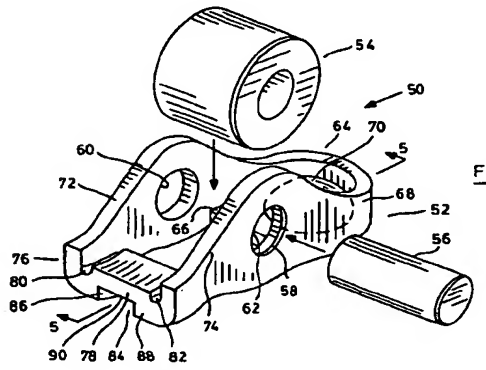

FIG. 3

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Description

Technical Field

This invention relates to finger followers used to transfer rotary motion from an overhead camshaft into reciprocal motion of poppet valves used as inlet and outlet valves in an engine. More particularly, the invention relates to an improved finger follower arm for assembly with a roller bearing used to engage with a cam of an overhead camshaft, the arm being made by stamping a steel blank and then forging to complete the arm.

Background Art

The present invention is particularly useful in automobiles which use internal combustion engines. Manufacturers of such engines have been concentrating for some time in making them more efficient while at the same time reducing the overall weight to improve the efficiency of the automobile generally. This has focused design efforts on making inexpensive, lighter finger follower arms which nevertheless have high structural rigidity to ensure accurate performance free of harmonic vibrations caused by repeated bending loads applied to the arm.

Although attempts have been made to cast such arms from various alloys, and to make arms from ceramic materials, the preferred method of manufacture continues to be stamping to form steel blanks and then to complete using appropriate forming and machining steps. This invention is directed to arms made from steel using primarily stamping techniques with the added step of forging part of the stamping.

Finger followers are initially stamped in one of two ways as illustrated by Figs. 1 and 2 which are labelled "Prior Art".

As seen in Fig. 1, a follower arm 20 has a domed socket 22 at a support post end 24 of the arm, and a poppet valve end 26 has a U-shaped cross-section. Generally, the structure is open downwardly so that an upwardly facing aperture 28 has to be provided for a roller bearing (as is conventional in the art). By contrast, a finger follower 30 seen in Fig. 2 is open upwardly. Both followers have advantages which will be apparent from the following comparisons.

The follower 20 is made by first stamping the general shape of the follower. At the other end, the U-shaped cross-section is shaped to accommodate a poppet valve end located between sides of the U-shaped section. The aperture 28 is post formed by pushing a die through the arm to finish form the opening by flaring the material and defining side walls 32, 34. These walls must be smooth and relatively accurately positioned to guide the aforementioned roller bearing. Lastly, openings 36, 38 are finished to receive a pin on which the bearing is mounted.

The arm 20 has a number of disadvantages which are generally thought to be outweighed by the advantage that the poppet valve end 26 is well formed to receive and locate an end of the poppet valve. The disadvantages include the difficulty of making the walls 32, 34 to the required specifications and the fact that the formation of the domed socket 22 inevitably results in a weakness in the structure between the socket and an adjacent transverse wall 40 bordering the aperture 28. To overcome this, relatively large gauge material must be used with resulting complications in stamping and forming as well as increased weight.

By contrast, the arm 30 shown in Fig. 2 has advantages where the arm 20 has disadvantages and vice versa. For instance, no opening 28 has to be formed so that the walls 42, 44 can be defined; and a domed socket 46 is contained within a peripheral wall which gives great rigidity. However, a poppet valve end 48 has no guide for the poppet valve consequently a disadvantage of this arm is that the arm relies entirely on alignment of parts and resistance to misalignment to keep the poppet valve and arm in the required relationship. This is undesirable because repeated loading will inevitably result in wear and gradual exacerbation of the problem.

It will be evident that a finger follower arm which has the advantages of both types of arms shown in Figs. 1 and 2 would be beneficial.

Disclosure of the Invention

A finger follower arm is provided for use with a bearing to form a finger follower of the type which in use is mounted on a support post to transmit oscillatory motion from a cam to a poppet valve to cause the valve to move linearly between open and closed positions. According to one aspect of the invention a steel finger follower is provided for mounting a steel finger follower arm on a support post to transmit oscillatory motion from a cam to a poppet valve to cause the valve to move between open and closed positions, the arm extending longitudinally and comprising:

a support post end including a downwardly open domed socket for engagement on said support post and an upstanding peripheral wall;

a tappet valve end spaced longitudinally from the support post end and having a bridge piece defining a downwardly open channel having longitudinally extending parallel side surfaces and a downwardly facing bearing surface between the side surfaces for engagement with said poppet valve;

a pair of upstanding spaced-apart parallel side walls defining aligned openings to mount a bearing, the side walls extending longitudinally between the support post end and the tappet valve end and blending into the peripheral wall, the peripheral wall

extending continuously between the side walls to rigidify the support post end,
the side walls, the support shaft end, and the poppet valve end combining to define an aperture providing clearance for said bearing;
a pair of longitudinally extending grooves between the bridge piece and the respective side walls; and
the poppet valve end having a W-shaped cross-section defined by the bridge piece, grooves, and the side walls.

In another of its aspects the invention provides a method of manufacturing a finger follower of the type having a support post end, a tappet valve end and a pair of upstanding faced-apart side walls extending between said ends, the method comprising the steps;

stamping the general form of the finger follower from steel sheet material with the poppet valve end having a U-shaped cross-section;
forming the tappet valve end by causing metal flow from the U-shaped cross-section to a W-shaped cross-section which includes a bridge piece bordered by a pair of grooves adjacent the side walls and a downwardly opening channel for engagement on a poppet valve; and
finish machining the finger follower.

Brief Description of the Drawings

Figs. 1 and 2 show prior art finger follower arms;
Fig. 3 is an exploded isometric view from the top and one side of a preferred embodiment of finger follower arm in accordance with the invention and shown with parts of a roller bearing to be assembled in the arm to complete a finger follower;
Fig. 4 is an isometric view from the bottom of the other side of the finger follower arm;
Fig. 5 is a sectional side view on line 5-5 of Fig. 3 with the finger follower assembled and showing in ghost outline parts of a support post and a poppet valve; and
Figs. 6 and 7 are diagrammatic views illustrating one of the steps used to make the finger follower arm.

Best Mode for Carrying Out the Invention

As previously discussed, Figs. 1 and 2 show exemplary prior art finger follower arms which illustrate the advantages and disadvantages of prior art structures. The remainder of the Figs. illustrate aspects of the present invention.

Reference is now made to Fig. 3 which illustrates a finger follower arm indicated generally by the numeral 50.

The finger follower 50 includes an arm 52 and a roller bearing 54 which, on assembly, includes a pin 56 held in place by staking ends of the pin into a chamfer 58 (one of which can be seen) around openings 60, 62 in the arm 52. Such roller bearings are conventional in the art.

The arm 52 includes a support post end 64 having a partial floor 66 from which extends an upstanding peripheral wall 68 which extends about a downwardly opening domed socket 70 positioned so that the floor 66 connects the socket to the peripheral wall 68. This wall blends smoothly into a pair of spaced-apart and parallel upstanding side walls 72, 74 which define the respective openings 60, 62 for the pin 56.

The side walls 72, 74 terminate at a tappet valve end 76 which has a generally W-shaped cross-section including a bridge piece 78 including at its ends a pair of parallel grooves 80, 82 located adjacent ends of the side walls 72, 74.

The tappet valve end 76 also defines a downwardly opening channel 84 extending longitudinally of the arm 52 from an outer extremity of this end and defined by side surfaces 86, 88 and a downwardly facing bearing surface 90. As can be seen in Figs. 4 and 5, the surface 90 is downwardly convex to maintain sliding contact with the upper end of a poppet valve 91 (seen in ghost outline) as the finger follower moves angularly about the end 64 which is supported on a post 92, (also seen in ghost outline in Fig. 5). The upper end of the post 92 is hemispherical as is the corresponding shape of the domed socket 70 to provide angular sliding movement between these parts.

As will be described, the arm 64 is formed initially with a generally U-shaped section at the tappet valve end 76 and the end is completed by a second step to be described with reference to Figs. 6 and 7 to complete the W-shaped cross-section of this end.

Details of the underside of the arm 52 can be seen in Fig. 4. It will be clear in this view that the domed socket 70 is formed in effect from the partial floor 66. This floor combines with the side walls 72, 74 and the bridge piece 78 to define a rectangular opening 94. This opening both provides space for the roller bearing 54 and frees the bridge piece 78 for deformation into the W-shaped section as will be explained with reference to Figs. 6 and 7. The opening can also be seen in Fig. 5 which is a sectional view on line 5-5 of Fig. 1.

Reference is next made to Fig. 6 to illustrate the forming step used to complete the shape of the tappet valve end in 76 (Fig. 3) which starts as a U-shaped section illustrated at 100 in Fig. 6 and ends as a W-shaped cross-section previously seen in Fig. 3 and illustrated also in Fig. 7.

The U-shaped section 100 is positioned in a lower die 102 which is shaped to accommodate the width of the arm and includes an upstanding ridge 104 which is the complementary shape of the channel 84 seen in Figs. 3 and 4. An upper die 106 has a projecting lower surface including a pair of spaced-apart ribs 108, 110 separated by a central surface 112. The ribs and central

surface complement the upper features of the bridge piece 78 including the grooves 80, 82 seen in Fig. 3. The upper die 106 also incorporates a pair of shoulders 114, 116 proportioned to engage upright wall portions 118, 120 of the arm as the upper die is closed with the lower die in the manner illustrated in Fig. 7. As these dies come together under load, metal flow takes place to transfer material from the U-shaped section shown in Fig. 6 into the W-shaped section shown in Fig. 7. To enhance this flow, the U-shaped section is effectively separated from the major parts of the arm by the rectangular opening 94 which defines the limit of the material to be effected by the dies coming together. It will be evident from a comparison of Fig. 6 and 7 that the dies will create the W-shaped tappet valve end 76 using normal forging and metal flow techniques and that the channel 84 (Fig. 1) is narrower than the extent of the bridge piece between the grooves 80, 82.

It will be evident to a person skilled in the art that various shapes of finger follower arm can be made within the scope of the Invention, and such shapes are included within the scope of the claims.

Industrial Applicability

Finger followers of the type described are used extensively in internal combustion engines to operate poppet valves which control the flow of intake and exhaust gases.

Claims

1. A steel finger follower arm for mounting on a support post to transmit oscillatory motion from a cam to a poppet valve to cause the valve to move between open and closed positions, the arm extending longitudinally and comprising:

   a support post end including a downwardly open domed socket for engagement on said support post and an upstanding peripheral wall;
   a tappet valve end spaced longitudinally from the support post end and having a bridge piece defining a downwardly open channel having longitudinally extending parallel side surfaces and a downwardly facing bearing surface between the side surfaces for engagement with said poppet valve;
   a pair of upstanding spaced-apart parallel side walls defining aligned openings to mount a bearing, the side walls extending longitudinally between the support post end and the tappet valve end and blending into the peripheral wall, the peripheral wall extending continuously between the side walls to rigidify the support post end,
   the side walls, the support shaft end, and the poppet valve end combining to define an aperture providing clearance for said bearing;
   a pair of longitudinally extending grooves between the bridge piece and the respective side walls; and
   the poppet valve end having a W-shaped cross-section defined by the bridge piece, grooves, and the side walls.

2. A steel finger follower arm as claimed in claim 1 in which the extent of the bridge piece between the grooves is greater than the distance between said side surfaces of said channel.

3. A steel finger follower arm as claimed in claim 1 in which the support shaft end further includes a partial floor bordering said aperture and extending between the domed socket and the peripheral wall.

4. A method of manufacturing a finger follower of the type having a support post end, a tappet valve end and a pair of upstanding faced-apart side walls extending between said ends, the method comprising the steps;

   stamping the general form of the finger follower from steel sheet material with the poppet valve end having a U-shaped cross-section;
   forming the tappet valve end by causing metal flow from the U-shaped cross-section to a W-shaped cross-section which includes a bridge piece bordered by a pair of grooves adjacent the side walls and a downwardly opening channel for engagement on a poppet valve; and
   finish machining the finger follower.

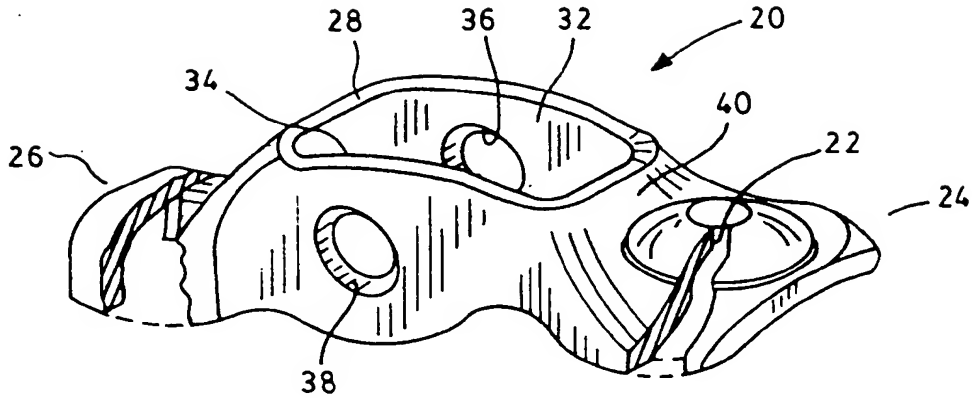


FIG. 1

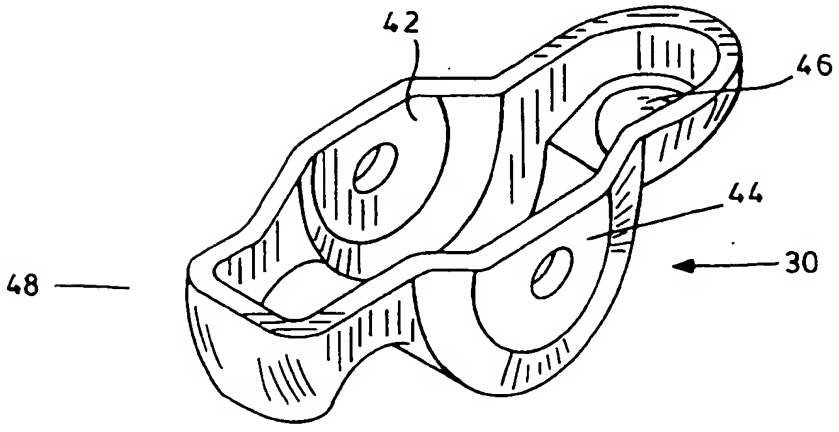


FIG. 2

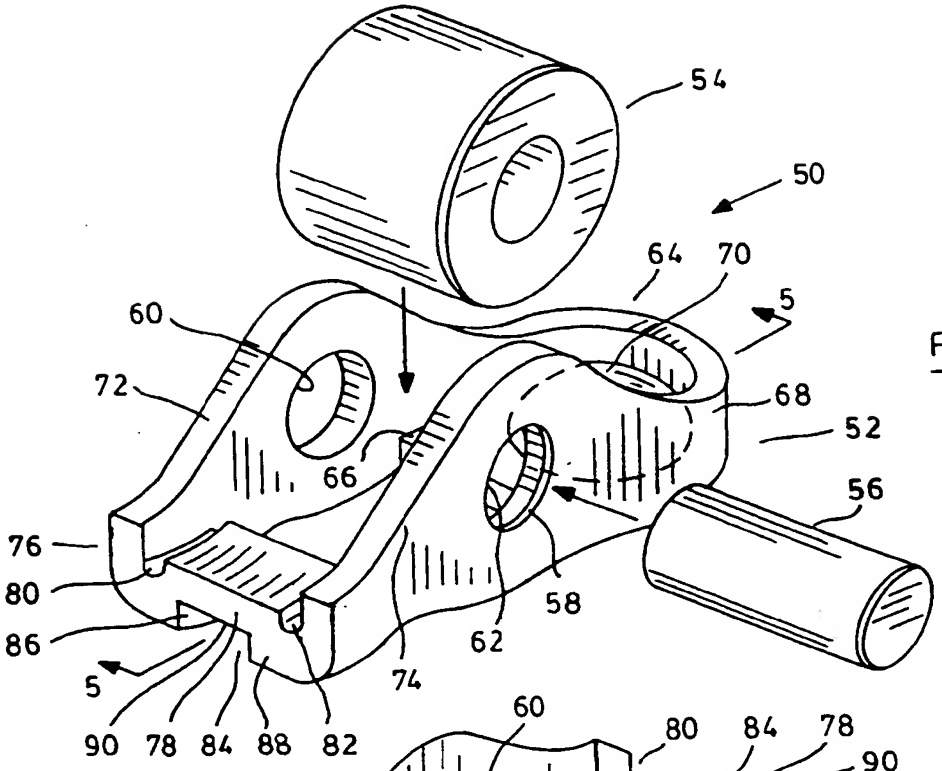


FIG. 3

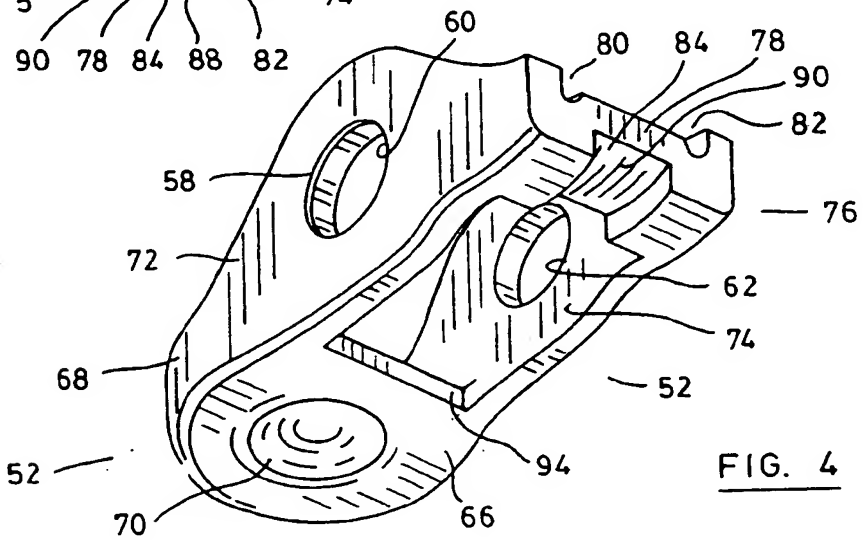
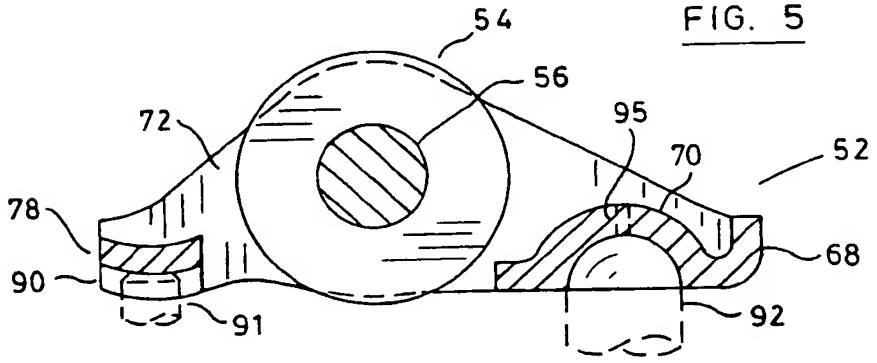


FIG. 4

FIG. 5



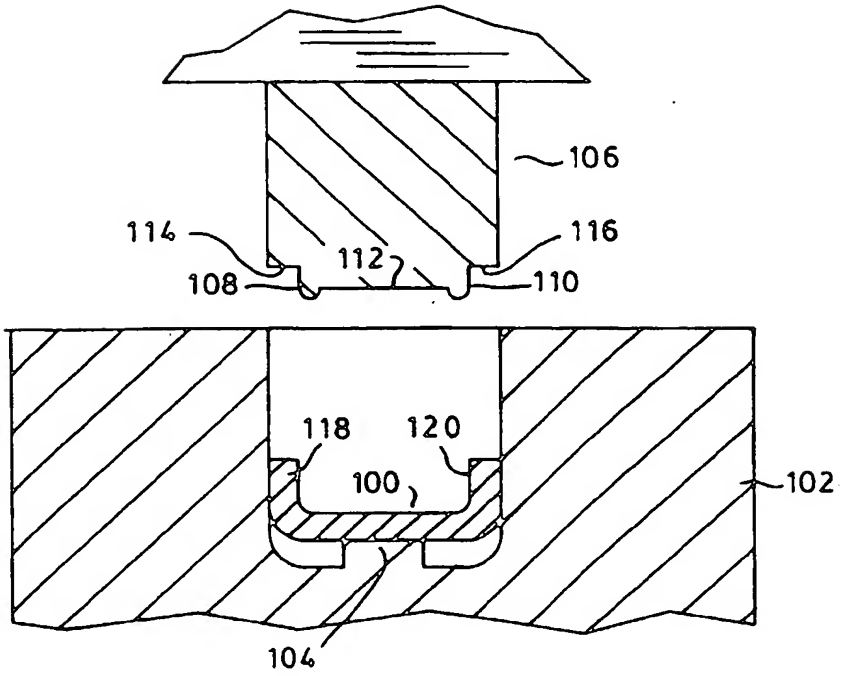


FIG. 6

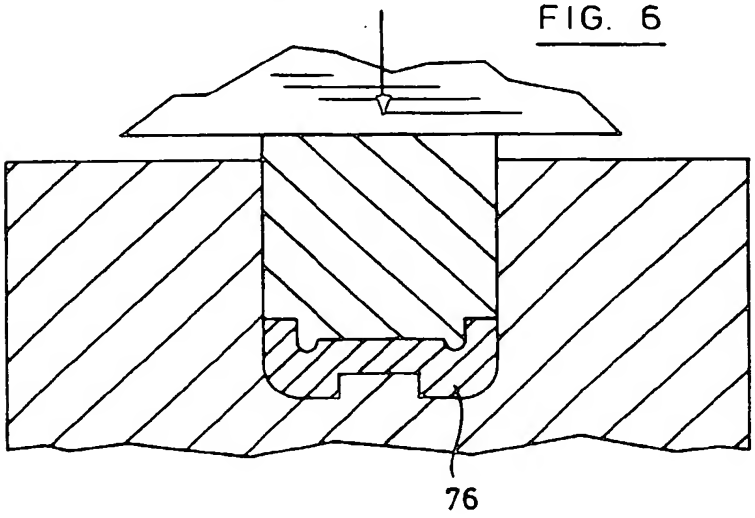


FIG. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 96 12 0301

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 5 372 097 A (JOSEPH KENNETH ET AL) 13 December 1994 * column 5, line 11 - line 49 * * column 6, line 36 - line 43 * * figures 2-6 *	1,4	F01L1/18
X	US 5 016 582 A (MILLS JESSE V) 21 May 1991 * column 2, line 47 - column 3, line 49 * * figures 2-7 *	1,2,4	
A	EP 0 573 674 A (MITSUBISHI) 15 December 1993 * column 11, line 20 - line 32 * * figure 20 *	1,3	
A	US 5 535 641 A (UCHIDA) * column 3, line 13 - line 27 * * figures 1,2 *	1,3,4	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

F01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	4 April 1997	Lefebvre, L

CATEGORY OF CITED DOCUMENTS

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